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THE ABUNDANCE, DISTRIBUTION AND DIVERSITY OF AQUATIC MACROPHYTES IN RIVER NGADDA, MAIDUGURI, NIGERIA.

Abbator Ahmed,^{1*} Fatima. S. Ahmed,² Musa A. Ibrahim³ and Zakari Mohammed⁴

^{*1} Department of Botany, Faculty of Life Sciences, University of Maiduguri. P.M.B 1069, Maiduguri, Borno State. Email. abbatorahmed@gmail.com

²Department of Botany, Faculty of Life Sciences, University of Maiduguri. P.M.B 1069, Maiduguri, Borno State. Email. fatimasamiraahmed@gmail.com

³Department of Biology, Faculty of Life Sciences, University of Maiduguri. P.M.B 1069, Maiduguri, Borno State.

⁴Department of Pure and Applied Chemistry, Faculty of Physical Sciences, University of Maiduguri, P.M.B 1069, Maiduguri, Borno State, Nigeria.

Corresponding Author's Email: abbatorahmed@gmail.com

ABSTRACT

Aquatic macrophytes are considered photosynthetic organisms of freshwater habits. They play an important role in the structure and functioning of freshwater ecosystems. Aquatic macrophytes abundance, distribution and diversity were investigated for a period of twelve (12) months from June 2021-May 2022 at downstream River Ngadda along Lagos Bridge in Maiduguri, Borno State, Nigeria. Aquatic macrophytes were collected at four (4) sampling stations in the study area, using standard operation procedures. During the study period, a total of 227 aquatic macrophytes with thirteen (13) macrophytes species that belonged to seven (7) families were identified and collected, comprising a total of 22 *Vossia Cuspidata* with a relative abundance of 9.7% in all stations, 18 *Lemna minor* (7.9%), 19 *Lemna trisulca* (8.4%) abundance, 15 *Cyperus rotundus* (6.6%), 28 *Carex acuta* (12.3%), 12 *Cyperus difformis* (5.3%), 12 *Cyperus iria* (5.3%), 15 *Potamogeton pectinatus* (6.6%), 19 *Potamogeton pectinatus* (8.4%), 22 *Echinochloa colona* (9.7%), 15 *Vallisneria spiralis* (6.6%), 18 *Alternanthera sessilis* (7.9%) and 12 *Ruppia spiralis* (5.3%) abundance was encountered during the study. The computation of Shannon-Wiener index of macrophytes revealed that station 1 had the highest species diversity (2.54), station 2 (2.40) and station 4 (2.36) recorded medium diversity while station 3 had the lowest diversity (1.27). Despite the River Ngadda being supportive of the growth of Cyperaceae and Poaceae which are family of grass weeds, aquatic macrophytes abundance, distribution and diversity in the River Ngadda is generally low.

Keywords: Abundance, Distribution, Diversity, Macrophyte, River Ngadda

INTRODUCTION

Aquatic macrophytes are considered photosynthetic organisms of freshwater habits, comprising vascular plants, aquatic bryophytes and a macro-algae growing permanently or temporally in aquatic environment [1]. They play an important role in the structure and functioning of freshwater ecosystems [2,3]. The macrophytes serves as a base of aquatic food chains, and they also actively contribute to the promotion and maintenance of food webs services in freshwater ecosystem [4,5]. Aquatic macrophytes also act as important bio-indicators of environmental conditions and long term ecological changes in water quality [6]. The function of macrophytes in these ecosystem is related to their structural attributes like species composition, distribution, abundance and diversity, which in turn relies on various environmental factors such as light, water, temperature, substrate composition, disturbance, competitive interactions, herbivory, epiphyte loading, water levels, water quality and sediment nutrients [7,8]. Apart from these, factors such as composition and properties of sediments have significant effect on the diversity and distribution of certain macrophytic species. Vegetative and clonal reproduction is considered to be the major mechanism for population growth and dispersal of macrophytes as sexual reproduction and genetic recombination are often subordinate strategies [9]. The efficient reproduction strategies and good dispersal capabilities are the two factors that help some aquatic macrophytes to become cosmopolitan in distribution and display high level of polymorphism and phenotypic plasticity in response to variations of environmental factors [10]. Aquatic macrophytes live in wet habitats. “True” aquatics, or hydrophytes, occur in permanently wet places, but others known as helophytes are more amphibious and may tolerate seasonal drying. The distribution and abundance of aquatic plants are influenced by variations of environmental factors that can be used to identify species and communities that are reliable indicators of important changes in their ecosystem, including ones that may serve as gauges of ecological integrity [11]. The usefulness of indicators is related to their sensitivity to both longer- and shorter-term changes in environmental factors, including those that act individually, or in a synergetic manner, to cause changes that may be interpreted as being beneficial or damaging. Aquatic plants can be successfully used for these useful purposes, alone or in association with the monitoring of other kinds of organisms [12,13].

Macrophytes in River Ngadda of Maiduguri, Borno State have not been studied in any great detail, which means that a framework for the accurate assessment of their species richness is still lacking. This study was conducted to determine the abundance and diversity of aquatic macrophytes in River Ngadda which will provide important information that can be used for its management purposes.

MATERIALS AND METHODS

Study Area

Maiduguri is located between the latitude $11^{\circ} 51' - 11^{\circ} 55' \text{N}$ and longitude $13^{\circ} 02' - 13^{\circ} 16' \text{E}$. It lies on a vast open plain, which is flat with gentle undulations at an average elevation of 354m above sea level. The climate of the region is characterized by a cool-dry season (October to march), the hot-dry season (April to June) and a rainy season (July to September). The area is also highly vulnerable to desertification [14]. The study area dominantly derives its groundwater resources from the Chad formation, which is the youngest stratigraphic unit of the Chad Basin and the most prolific in terms of groundwater resources. The river flows in a north-easterly direction, which originates from river Yedzeram and river Gombole, which meet at a confluence at Sambisa Forest both in Nigeria, and it flows as river Ngadda in to Alau Dam and stretches down across Maiduguri then empties into Lake Chad. The river is used for various human activities such as fishing, irrigation, bricks making and residents along the riverbank use it for bathing, washing and as drinking water by animals. The river receives copious amounts of wastes from residential houses and abattoirs sited along its course.

Sampling Sites

Sampling sites were chosen based on factors such as volume of water, accessibility, security and human activities around the area. The sampling stations were located at River Ngadda near Lagos bridge in Maiduguri where four (4) sampling stations were chosen randomly covering both side of the bridge (left and right). Two (2) sampling stations 1 and 2 were situated at the left side of the bridge and station 3 and 4 were situated at the right side of the bridge. Sample collection was conducted biweekly from June 2021-May 2022 covering both rainy and dry season and aquatic macrophytes were collected at the river banks and water surface for floating macrophytes at all the sampling stations.

Collection and Identification of Aquatic Macrophytes

Aquatic macrophytes both creeping and standing were collected along the river banks and on the surface waters for the floating ones each time trip was made to the site for a period of Twelve (12) months. Macrophytes were collected with the aid of shovel, rake and hand pulling. Collected macrophytes were arranged in white paper and covered with brown paper envelop to avoid drying up. It was quickly transported to the Laboratory, department of Botany, University of Maiduguri, for identification. Macrophytes were identified from family to species level with the use of Handbook of West African weeds [15].

Statistical Analysis

Data collected for aquatic macrophytes were subjected to descriptive statistics to determine species abundance using frequency and percentages. Shannon-Wiener Diversity Index and Equitability Index were used to determine Macrophyte diversity at the sampling stations.

Results

Abundance of Aquatic Macrophytes

A total of two hundred and twenty-seven (227) macrophytes were collected, out of which 73 (32.2%) were collected at Station 1, 65 (28.6%) were collected at Station 2, 22 (9.7%) were collected at Station 3 and 67 (29.5%) macrophytes were collected at Station 4. The Macrophytes from sampling stations belong to thirteen (13) species from Seven (7) families. The family *Araceae* has two species which are *Lemna minor* and *Lemna trisulca*. The population of *Lemna minor* was 18 with 7.9% abundance. Similarly, nineteen (19) of *Lemna trisulca* were collected in all the four (4) stations with an abundance of 8.4%. The Family *Cyperaceae* has four (4) species namely; *Cyperus rotundus*, *Carex acuta*, *Cyperus difformis* and *Cyperus iria*. 15 of *Cyperus rotundus* were collected at all stations with an abundance of 6.6%. From the stations, a total of twenty-eight (28) *Carex acuta* were collected with abundance of 12.3%, twelve (12) *Cyperus difformis* were collected from the stations with 5.3% abundance, Similarly, twelve (12) *Cyperus iria* were collected from the stations with 5.3% abundance. Family *Potamogetonaceae* has two (2) species which are *Potamogeton pasillus* and *Potamogeton pectinatus*. 15 of *Potamogeton pasillus* were collected with 6.6% abundance and nineteen (19) of *Potamogeton pasillus* were collected in all the four (4) stations with an abundance of 8.4%. Family *Poaceae* had two species also which are *Vossia cuspidata* and *Echinochloa colona*, a total of twenty-two (22) *Vossia cuspidata* with an abundance of 7.4% were collected at four sampling stations and 22 *Echinochloa colona* with an abundance of 9.7% were collected at three sampling stations. Family *Hydrocharitaceae* have one species i.e. *Vallisneria spiralis* and 15 *Vallisneria spiralis* were collected with 6.6% abundance across the sampling stations. Family *Amaranthaceae* also recorded one species i.e. *Alternanthera sessilis* with total of eighteen (18) *Alternanthera sessilis* collected with abundance of 7.9% and *Ruppiaceae* recorded one species which is *Ruppia spiralis* with total of twelve (12). *Ruppia spiralis* were collected with abundance of 5.3% in three sampling stations. The result of this study is shown in Table 1.

Aquatic Macrophytes Diversity

The sampling sites show diversity among Macrophytes species collected at different sampling stations. Shannon Diversity Index (H) of the site, $H=2.53$ which indicates that there is high diversity among macrophytes population in the site. However, Shannon Diversity Index of macrophytes varies at the sampling stations. At Station 1, $H=2.54$ which indicates high diversity. Station 2 has $H=2.46$ which indicates medium diversity while Station 3 has $H=1.27$ which indicates low diversity and Station 4 has $H=2.36$ which also medium diversity. In addition to that, the Equitability Index (EI) shows that stations 1, 2 and 4 have EI of 1.0, 0.97 and 0.93 which signifies high diversity while EI at Station 3 is 0.5 which signifies medium diversity. The result of this study is shown in Table 2.

Table 1: Aquatic Macrophyte Abundance and Distribution along River Ngadda (Lagos Street Bridge) from June, 2021 – May, 2022

Family	Species	Stations				Total	Abundance (%)
		1	2	3	4		
Araceae	<i>Lemna minor</i>	5(27.8%)	5(27.8%)	3(16.7%)	5(27.8%)	18	7.9
	<i>Lemna trisulca</i>	5(26.3%)	6(31.6%)	0(0.0%)	8(42.1%)	19	8.4
Cyperaceae	<i>Cyperus rotundus</i>	4(26.7%)	6(40.0%)	0(0.0%)	5(33.3%)	15	6.6
	<i>Carex acuta</i>	8(28.6%)	5(17.9%)	6(21.4%)	9(32.1%)	28	12.3
	<i>Cyperus difformis</i>	6(50.0%)	6(50.0%)	0(0.0%)	0(0.0%)	12	5.3
	<i>Cyperus iria</i>	7(58.2%)	5(41.7%)	0(0.0%)	0(0.0%)	12	5.3
Potamogetonaceae	<i>Potamogeton pasillus</i>	6(40.0%)	0(0.0%)	4(26.7%)	5(33.3%)	15	6.6
	<i>Potamogeton pectinatus</i>	6(31.6%)	4(21.1%)	4(21.1%)	5(26.3%)	19	8.4
Poaceae	<i>Echinochloa colona</i>	7(31.8%)	9(40.9%)	0(0.0%)	6(27.3%)	22	9.7
	<i>Vossia cuspidate</i>	6(27.3%)	5(22.7%)	5(22.7%)	6(27.3%)	22	9.7
Hydrocharitaceae	<i>Vallisneria spiralis</i>	5(33.3%)	4(26.7%)	0(0.0%)	6(40.0%)	15	6.6
Amaranthaceae	<i>Alternanthera sessilis</i>	3(16.7%)	6(33.3%)	0(0.0%)	9(50.0%)	18	7.9
Ruppiaceae	<i>Ruppia spiralis</i>	5(41.7%)	4(33.3%)	0(0.0%)	3(25.0%)	12	5.3
Species Total		73(32.2%)	65(28.6%)	22(9.7%)	67(29.5%)	227	100
Shanon Diversity Index		2.54	2.46	1.27	2.36		
Equitability Index		1.00	0.97	0.50	0.93		

Table 2: Seasonal Macrophytes Species occurrence in River Ngadda

Species	Harmattan (Oct – Feb)	Dry Season (March – May)	Wet Season (Jun-Sept)
Free Floating			
1. <i>Lemna minor</i>	-	-	+++
2. <i>Lemna trisulca</i>	+ -	- -	+++
Submerged			
1. <i>Carex acuta</i>	+++	--	+++
2. <i>Vallisneria Spiralis</i>	--	- -	+++
3. <i>Potamogeton pasillus</i>	+ - -	- - -	+++
4. <i>Potamogeton pectinatus</i>	- - -	- - -	+++
5. <i>Ruppia spiralis</i>	+ - -	- - -	+++
Emergent			
1. <i>Cyperus rotundus</i>	- - -	- - -	+++
2. <i>Alternanthera sessilis</i>	+ - -	- - -	- ++
3. <i>Echinochloa colona</i>	+ - -	- - -	+++
4. <i>Cyperus difformis</i>	+ - -	- - -	+++
5. <i>Cyperus iria</i>	+ - -	- - -	+++
6. <i>Vossia cuspidata</i>	+ - -	- - -	+++

Key: + = Present.

- = Absent

DISCUSSION

The aquatic macrophytes species found during this study and its abundance (number of species found) are common aquatic macrophytes found in various part of Nigeria (Ita 1994). A total number of 13 species from 7 families (*Araceae*, *Cyperaceae*, *Potamogetonaceae*, *Poaceae*, *Hydrocharitaceae*, *Amaranthaceae* and *Ruppiaceae*) were identified during this study where *Cyperaceae* have the highest number of species with four (4) species, then *Araceae*, *Potamogetonaceae* and *Poaceae* recorded two (2) species each while the other families recorded one (1) specie each. Species from *Cyperaceae* and *Poaceae* were the most dominant species with high abundance +++ then rare abundance was observed in the other families. This statistic showed that, the river had more of grass weed macrophytes than the root knot or leguminous weed macrophytes which gained the support of Ita [16] who revealed the abundance of weed aquatic plants in various part of Nigeria.

Higher number of macrophytes species at station 1, 2 and 4 attributable to be because of their fertility status, drainage patterns and types of activities along the catchment (refuse dumps, diffluent discharge, grazing, soil and sand excavation for construction works and washing). This collaborates the findings of Wandell and Wolfson [17] who reported that a lake (or water bodies) fertility and its amount of aquatic plants is greatly influenced by its watershed characteristics, topography, soil fertility, drainage patterns and land use. These watershed characteristics determine the quantity of nutrients such as nitrate and phosphate that will be washed into the water body from land to stimulate plant growth. At station 3 lesser number of macrophytes was recorded, this might be due to minimal activities carried out at the watershed that nutrients (nitrate and phosphate) were available in less quantity and thus distribution of macrophytes was also affected.

The aquatic species of macrophytes that occur in river Ngadda are few. The species abundance and distribution results confirmed that the two (2) seasons (Dry and the rainy season) influenced the abundance and diversity of the aquatic macrophytes in the river. The distribution of species (13 species) recorded in the river in all the seasons were very low in comparison with those in similar environments, Idowu and Gadzama [18] recorded 38 species in Lake Alau, Elemi (1990) recorded 278 species in Ibadan, [19] recorded 215 species in northern Tanzania.

Fewer species of aquatic macrophytes in river Ngadda during the dry season may be due to the climate regime of the arid environment which may impose extreme heat due to high temperature on the macrophytes environment. This agreed with the findings of Obot [20] who observed that the climatic regime changes aquatic macrophytes vegetation as well as soil stability in the arid region. Other reasons may be due to the effect of minimal concentration of nutrients and grazing effect which led to loss of plants in major areas around this period.

The high species population recorded in the rainy season was as a result of increase in water level and flooding period which could have brought nutrients that favoured the increase in aquatic vegetation and other biological communities. This finding is in conformity with the findings of Idowu and Ngamarju [21] who reported high species composition of aquatic macrophytes at Lake Alau (Nigeria) in the rainy season which was attributed to increase in water level and flooding regime. It also agrees with Ita [16] which reported that rainfall has direct influence on the distribution and abundance of aquatic vegetation.

CONCLUSION

River Ngadda supports the growth of *Cyperaceae* and *Poaceae* which are family of grass weeds. From most research carried out in lakes, dams and Rivers on aquatic plants, it has been observed that, aquatic macrophytes abundance, distribution and diversity in River Ngadda to be low. Seasonal variation occurred in the aquatic macrophytic vegetation; some species die or disappear with the change of the season. Variation is not only in season but also in stations. Thus, it is recommended that, the success of utilization of aquatic macrophytes at a sustainable level can only be achieved if the habitats of these macrophytes are properly managed, this demand habitat conservation. Even though some aquatic macrophytes pose obnoxious threat to the ecosystem, they could still be used in various ways to make them environmentally friendly with sustainable aquatic macrophytes control by the

riparian communities at low cost and for added economic benefits. Any conservation efforts in Maiduguri should solicit local support through awareness.

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